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METAMORPHIC CONDITIONS IN THE NILGIRI GRANULITE TERRANE AND THE ADJACENT MOYAR AND BHAVANI SHEAR ZONES: A REEVALUATION

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The Nilgiri Hills massif, a tilted and uplifted segment of late Archaean crust is made up of garnet and hypersthene-bearing enderbitic to charnockitic rocks with layers and bodies of mafic pyroxene-plagioclase rocks with or without garnet and enclaves of pyroxenitic rocks. Granulite facies metamorphism occurred about 2.5 Ga ago and closely followed the emplacement of the igneous protoliths (1). The crustal segment of the Nilgiri Hills evidently represents an early Proterozoic addition to the Archaean Dharwar craton in the north, and the separating Moyar shear zone a major suture zone. The Bhavani shear zone to the south, on the other hand, is regarded as reworked Nilgiri-type crust. High-grade metamorphism in the Bhavani and Moyar shear zones and the adjacent Dharwar craton is coeval with the granulite facies event in the Nilgiri Hills massif (1,2,3).

Previous estimates of metamorphic conditions in the Nilgiri Hills and adjacent shear zones indicate temperatures between 700 to 850 ^{o}C and pressures of 7 to 10 kb (2,4,5,6,7). Only recently it has been pointed out (8) that the calibrations of garnet-pyroxene thermometers and garnet-pyroxene-plagioclase-quartz barometers employed in these studies, are afflicted with erroneous assumptions regarding mixing properties of the ferromagnesian phases. It is likely, therefore, that much of the scatter in the reported P-T data is an artifact of variations in the bulk chemistry of the rocks.

To derive improved estimates of metamorphic conditions in the Nilgiri block and the adjacent shear zones and to assess spatial P-T gradients with more confidence, an up-dated reevaluation of P-T-X_{fl} conditions was carried out. It is exclusively based on critically revised and internally consistent thermometers and barometers and on an extensive set of mineral composition data from more than 60 garnet-pyroxene-bearing rock specimens of wide-ranging composition. Only core compositions of the coexisting phases were used in the computations and the P-T estimates are thought to reflect near-peak conditions of granulite facies metamorphism. The temperature data calculated with several Fe-Mg exchange thermometers (gar-cpx, gar-opx, gar-bio, opx-bio) are in agreement and indicate almost isothermal equilibration at 730 + 30 ^{o}C in the entire Nilgiri block and the adjacent shear zones. The pressure data obtained from gar-opx-plag-qtz barometry document a continuous regional gradient from about 7.5 -- 8 kb in the Bhavani shear zone to 8.7 -- 9.2 kb in the northern margin of the Nilgiri block and the Moyar shear zone. The abrupt increase in pressure values at the northern

margin of the Nilgiri Hills reported by earlier workers (6,7) does not exist and obviously resulted from the effects of bulk chemistry on the barometric calibrations. North of the Moyar shear zone, in the deepest part of the Dharwar craton, a similar P-T regime prevailed during upper amphibolite to granulite facies metamorphism (750 + 70 ^{o}C and 8 + 1 kb; cf. 2,6,9).

The abundance of high-density carbonic fluid inclusions (10) documents that the granulites in the Nilgiri crustal segment equilibrated in the presence of extremely CO_2-rich pore fluids. The homogenization temperature data (Th -52 to 19 ^{o}C; peak between -40 to -27 ^{o}C) and derived density values indicate fluid entrapment near peak metamorphic conditions. The source of fluids is not known. The absence of carbonate rocks and the rareness of graphite-bearing metasediments in the Nilgiri granulite terrane, however, suggests pervasive influx of carbonic fluids from deeper levels.

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